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CHEMICAL WARFARE: A PRIMER ON AGENTS, MUNITIONS, AND DEFENSIVE MEASURES

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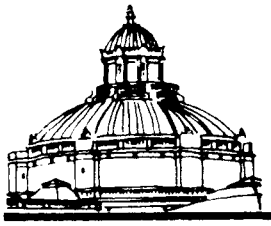

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ABSTRACT

The recent Department of Defense proposal to develop a capability to modernize and expand the current U.S. chemical warfare munition stocks with binary nerve agent munitions has focused attention on the subject of chemical warfare. This paper provides a brief introductory discussion of modern chemical warfare, describing the types of agents, delivery methods, and defense against chemical agents. It does not discuss policy, strategy, tactics, or disarmament aspects of chemical warfare. These issues will be covered in CRS Issue Brief IB81081.

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CHEMICAL WARFARE: A PRIMER ON AGENTS, MUNITIONS, AND DEFENSIVE MEASURES

INTRODUCTION

The subject of this paper is those chemical weapons that could be used in a major conflict involving U.S. forces against a chemically equipped and trained opponent. Such a situation has not occurred in any major war since World War I. 1/ This fact does not eliminate chemical warfare from the concern and planning of the U.S. military, however. Indeed, the defense establishment has long maintained primarily defensive, but also limited offensive, chemical warfare capabilities. Moreover, the Department of Defense (DOD) currently proposes to establish a capability to modernize and expand the current U.S. chemical warfare munition stocks with binary nerve agent munitions. This proposal has focused increased congressional attention on the subject of chemical warfare. This paper provides the unfamiliar reader with a brief introductory discussion of chemical warfare and is intended as an aid in understanding the complex issues surrounding the proposal to modernize and expand the present chemical stocks. These issues will be covered in CRS Issue Brief IB81081.

This paper does not attempt to explain the present United States policy on chemical warfare, the strategy and doctrine of chemical weapon employment, the merits of chemical munitions as battlefield weapons, or the status and debate

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1/ The United States used both riot control agents and herbicides during the Vietnam War, actions which U.S. policy does not regard as engaging in chemical warfare.

on chemical disarmament. Its sole purpose is to describe the technological ingredients of present-day chemical warfare, i.e., the chemical agents, the delivery systems, and defensive measures. Any description of modern chemical warfare is predominantly based on analytical data, since the only combat data available were generated during World War I. Since then, many innovations have been made but their impact on the modern battlefield is speculative and open to debate.

CHEMICAL AGENTS

Chemical agents cause toxic damage to a living organism by reacting chemically with living tissues (physiological effect) rather than through direct physical impact from blast or heat. They are released either in liquid or gas form on a target area. Additionally, chemical agents affect only living organisms (i.e., they are biospecific) and do little damage to physical structures, though persistent agents can be used to deny use of structures and areas to opponents.

Many different agents are available for use as chemical weapons. Most of them have been available for many years and some were used during World War I. Mustard gas is an agent which was widely used during that conflict. Nerve agents, the latest known developed chemical agents to be incorporated into U.S. and Soviet stockpiles, were first discovered in the late 1930s.

The variety of chemical agents available today can be used in combination to further complicate defensive measures. Chemical agents can be dispersed as liquids or gases, which cause injury through inhalation and/or body surface contact. For wide military application chemical warfare agents must possess

certain qualities to make them militarily useful. The most important qualities include:

1. Stability - This denotes the quality of an agent to retain its potency until used. A highly stable agent can be safely stored, easily handled and remain potent for an extensive period of time.

2. Potency/Lethality - An effective chemical warfare agent should have a potency that allows for relatively small amounts to inflict the desired effect. This allows for effective agent amounts to be delivered by the military force using chemical weapons.

3. Persistence - This is the length of time a chemical agent remains effective after it has been disseminated on a target. Agents effective for twenty minutes or less are referred to as nonpersistent. Agents remaining effective for hours or days are considered persistent agents. Depending on the military mission, one or both of these qualities might be required.

4. Time of Effect - The time of effect is the span between delivery and onset of symptoms. Symptoms from some agents may not occur for hours after a chemical contamination, while nerve agents usually act quickly.

5. Ease of Production/Cost - To be militarily cost effective, agents should be capable of being mass produced at relatively low cost. Producing an agent with these qualities calls for an uncomplicated manufacturing process and relatively common ingredients.

Types of Agents

The military chemical agents described below include agents that cause serious impairment, significant injury, or death to those exposed to such agents. Defoliants (anti-plant agents) and harassing (riot control) agents are not

comparably discussed in this paper. This omission is not based upon the official U.S. legal and diplomatic position that these agents are not chemical warfare agents but on the current legislative context. The threat of a future chemical war between opponents equipped and trained in chemical warfare would involve the more potent agents. It is toward this aspect of the chemical warfare threat that the debate on proposed modernization of U.S. chemical capabilities is directed. 2/

Incapacitating Agents Causing Temporary Effects

These agents cause serious impairment to the ability of a person to function effectively. Incapacitation can extend for many hours and days but is generally non-fatal. Incapacitating agents are divided into physiochemical and psychochemical types. Physiochemical agents incapacitate a person by producing bodily impairment ranging from severe irritation to paralysis. CX, or phosgene-oxime, is an example of such agents causing nose and eye irritation. Psychochemical agents produce mental inabilities to perform even the simplest of tasks. LSD and BZ are the two most widely mentioned psychochemical agents on which the United States has done considerable research. However, they display unpredictable

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2/ Defoliants are not employed for direct effect on humans; they can have utility as economic or tactical weapons through impact on plants such as agricultural crops. (For a fuller background discussion of this aspect of warfare the reader is referred to an earlier CRS report, "Herbicides: Environmental Health Effects in Vietnam; and the Geneva Protocol: Developments During 1970" (70-303 SP), and "Ecological Consequences of the Second Indochina War," published by the Stockholm International Peace Research Institute (1976).) Harassing or riot control agents cause temporary and minor irritation and are effective for a short period of time; a military force trained and equipped for chemical warfare would be able to protect itself easily with gas masks. It should be noted, however, that much of the international literature in this area treats defoliants and riot agents as chemical warfare weapons.

effects and are expensive to produce. Soviet capability in the psychochemical area has not been well documented in the open literature.

Lethal Agents Causing Death or Very Serious Injuries

1. Blister Agents (Vessicants) - Blister agents produce general tissue irritation, and contact with the skin provokes burns and blistering. Eye injury is a common symptom and can lead to temporary loss of vision. Mustard agent, used during World War I, is the most noted of these agents and is currently available in U.S. and Soviet stocks. Generally, blister agents do not cause fatalities since lethal concentrations are difficult to establish in the field.

2. Blood Gases - These agents interfere with cell respiration. Hydrogen cyanide is an important member of this chemical warfare agent group. Gas masks provide almost complete protection, but the agent can rapidly saturate present gas mask filters requiring filter replacement and possibly exposing an individual to chemical agents. If blood gases are used in combination with fast reacting agents, like nerve agents, even protected military forces may experience combat casualties.

3. Lung Irritants - Lung irritants, widely used in World War I, injure the respiratory tissues. The development of nerve gases has somewhat reduced the importance of lung irritants as chemical warfare agents. Phosgene is the most noted agent in this group. The characteristics of phosgene allow it to be used as a lethal gas or at lower concentration to incapacitate by injuring body tissues. Gas masks provide total protection.

4. Nerve Agents - These agents impair the body's ability to regulate muscle action, causing uncontrollable muscular activity which leads to death through respiratory failure. Their effect is almost immediate. Nerve agents

are difficult to identify without special equipment because they are odorless and lack irritancy and color. They can be disseminated as vapors or liquids. Two types of nerve gases, V agents and G agents, are known to exist in the U.S. and Soviet inventories. Other types exist in the laboratory.

a. G Agents - These were the original nerve agents, whose effects occur through inhalation. Included within this group is GA(Tabun), GB(Sarin), GD(Soman), GE and GF. GB is stocked by the United States, and GD and GA are believed to be stocked by the Soviets. Their persistence varies from non-persistent GA to persistent GD.

b. V Agents - The later developed V agents have the characteristic of being absorbed through the skin, a fact which necessitates complete body protection to avoid contamination. V agents are of low volatility and therefore are considered persistent gases. The two most important agents are VE and VX. VX is in the U.S. inventory.

5. Binary Nerve Agents - Binary nerve gases, which are the intended products of the presently advocated U.S. offensive chemical modernization program, are similar to present nerve agents. The difference is that two relatively safe chemicals are placed in a munition, such as a bomb, with the mixing of the chemicals to form the nerve agent occurring after the munition is fired or released to its target.

WEAPONS AND DELIVERY METHODS

One very important characteristic of chemical munitions is that, once released to a target, they exhibit a lack of control significantly greater than conventional munitions. Conventional weapons are limited in range and duration of effect (instantaneous detonation). However, chemical munitions can produce

wide ranging effects because the released agent can be carried by wind or other factors away from the initial impact area.

Chemical agents have been incorporated into numerous types of weapon systems. Chemical weapons include shell-type munitions for artillery and mortars, surface-to-surface rockets and missiles, aircraft bombs and aircraft spray systems. The current modernization program recommended by the Army calls for the production of 155mm artillery shells, aircraft bombs, 8-inch artillery shells and possibly a rocket munition. The Soviet forces are believed to possess chemical munitions for artillery, mortars, multiple-rocket launchers, missiles and aircraft.

Artillery weapons allow for accuracy and medium range, mortars for high rate of fire in the immediate battlefield, rockets for rapid and massive area saturation, and aircraft bombs and sprays for greater range and area coverage. The main characteristic differentiating these present-day delivery systems from those of World War I is that they possess greater range, accuracy, and delivery capability.

DEFENSE AGAINST CHEMICAL WEAPONS

The development of chemical weapons has been paralleled by the development of methods and equipment to protect humans from the effects of these weapons. However, available defensive measures are not capable of total protection against all chemical agents on the battlefield, and these defenses require special training and degrade the combat efficiency of the user.

Defending against chemical agents is considered a much more demanding task than using chemical weapons. Defense against chemical weapons requires complex technology, a high degree of training, and an efficient and sophisticated support

organization. The United States, as well as NATO, devotes most of its chemical warfare activities and budget to defensive needs.

The ability to defend effectively against chemical weapons is predicated on detecting the presence of a chemical agent soon enough to take proper precautionary actions, the availability and ability to use proper defensive equipment, and the capability to provide effective antidote and medical treatment to counter the effects of chemical agents.

Detection of Chemical Warfare Agents

World War I combat data indicate that many of the poison gas attacks were accompanied by specific odor and/or color. However, newer chemical agents, including nerve gas agents, cannot be detected without the aid of special equipment because of their lack of odor, irritancy, and color. Nerve gas agents particularly can cause heavy casualties if proper defensive measures are not initiated immediately. Numerous types of detection alarm equipment have been developed to warn of the presence of chemical agents, but all have specific limitations. Detection equipment is also needed to assist in decontamination by indicating when an environment is free of chemical warfare agents. This equipment varies from very simple detection papers and powders to complex automatic alarm devices.

Automatic alarm devices are primarily designed to be used by military units to detect nerve agents. They provide audible and visual warning of the presence of a nerve agent. Such warning is indispensable because the lethality of these agents can kill or incapacitate an unprotected person almost instantly. Additionally, some nerve agent munitions can be purposefully targeted some distance from the location of a military unit and inflict lethal effects as a result of

cloud movement. Automatic detection devices can be placed some distance from a military unit to monitor the environment for the presence of nerve agents. Without the aid of automatic detection equipment, protective equipment such as masks or clothing must be worn whenever enemy nerve agent weapons are suspected of being used.

Protection from Chemical Agents

Protection against chemical agents has been developed for individual and collective use. Civilian populations would be significantly affected if chemical attacks were close to civilian populations and/or if attacks were directed on civilian centers. However, almost all protective developments have been oriented to military use.

The most familiar protective item is the gas mask. Masks provide protection for the face and respiratory passages from vapor, aerosol, and liquid forms of chemical agents. Protective garments are also standard items of protection for chemical warfare, intended to shield an individual from persistent chemical agents. They protect against agents that cause skin injury or internal body injury by entering the body through the skin.

Protective suits are either garments of rubberized fabrics or garments impregnated with chemical-absorbing charcoal material. The advantage of the non-rubberized garment is that air can pass through the suit, creating a relatively cooler environment for the wearer. The suit's disadvantage is that use is limited by the absorptive capability of the charcoal. How long a suit can be used depends on the agent concentration and the period the wearer is under chemical attack. Rubberized suits are not constrained by this characteristic and are simpler to decontaminate. However, these suits cause heat stress more

rapidly than air-permeable garments. Having to fight in either type of suit can be expected to have an adverse effect on operational performance.

Collective protection refers to the ability to provide protection from chemical agents to a number of persons in an enclosed area, a method that avoids need for individual protection, by keeping chemical contaminants on the outside of a structure or vehicle. Decontamination becomes a simpler procedure because vehicles and structures are easier to detoxify than personnel. Such protection can be provided in military vehicles such as tanks, command and control vans, and various types of shelters. Contamination from small leaks is avoided because of the higher internal pressure inside an enclosure than that of the outside environment. This system allows combat crews to work in standard military uniforms. The pressure concept can also be used to protect shelters or other facilities intended for medical treatment, command and control, troop rest, and decontamination purposes.

Chemical Agent Countermeasures

Decontamination

An individual, a piece of equipment, or a structure requires decontamination in order to avoid casualties and restore combat efficiency. Decontamination is not necessary for all chemical contamination. Persistent, stable chemical agents that are in liquid form present the greatest danger because they remain lethal for periods of time ranging from hours to days. Other types of agents that are unstable and have a short lethality time are so affected by weather, soil, temperature, and time that decontamination is naturally accomplished.

Powder and liquid decontaminants are available that can remove or detoxify contamination from individuals and equipment. Heat can be used to evaporate agents, and this method is used by Soviet military forces to decontaminate equipment.

Types of decontamination equipment range from hand-carried to truck-mounted units. Soviet equipment, which is considered the most sophisticated in the world, includes truck-mounted, rapid combat vehicle decontamination systems, portable shower facilities for troop decontamination and small equipment decontamination units mounted on trucks for field mobility.

Medical Countermeasures

Antidotes are not available for all chemical warfare agents, including some nerve agents. The available antidotes can generally keep people alive if further medical treatment is administered. They can be administered in the field, and survival is expected to be high if the antidote is used within minutes after contamination, and can be followed by further medical treatment. The primary problem is that the antidote is also a poison, and the side effects incapacitate the user for several hours to a few days. Individuals who take the antidote under the false impression that they have received nerve gas poisoning suffer similar incapacitation.

In sum, the protective countermeasures that would be required in chemical warfare are at best difficult, expensive, and time-consuming. The effects on combat efficiency would be disruptive.